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ABSTRACT

The teaching of science in the United States is dominated by examples of the contributions of European and American scientists. The multitude of contributions of knowledge and ways of thinking of the many other cultures of the world have been largely ignored. This paper presents evidence from the Yupiaq culture in southwestern Alaska that demonstrates that indigenous cultures have developed their own scientific bodies of knowledge and ways of thinking about the world that differs in crucial ways from that of Western Science. Yupiaq contributions to science and technology and Yupiaq world views are described. Implications for curriculum development and pedagogy are discussed. (JRH)

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INCORPORATION OF THE WORLD VIEWS OF INDIGENOUS CULTURES: A DILEMMA IN THE PRACTICE AND TEACHING OF WESTERN SCIENCE

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ABSTRACT

Is science an invention of European thought, or have scientific bodies of knowledge and ways of thinking emerged separately in other cultures worldwide? Evidence from the Yupiaq culture in southwestern Alaska demonstrates that indigenous cultures have developed their own scientific bodies of knowledge and world views that differ from Western ways of thinking. The paper challenges Western scientists and Western educators to study the scientific knowledge and world views of other cultures. The hegemony of Western science threatens to further disenfranchise indigenous cultures and perpetuates a colonialist attitude that cannot be defended in modern times.

INTRODUCTION

With its emphasis on controlled experimentation, replicability, and alleged objectivity, science as practiced in laboratories and as taught in American schools, differs dramatically from the practice and thinking found in many indigenous cultures. Does that mean that what occurs in these cultures is not truly science? Did modern scientific knowledge originate in European thinking, or are there multiple points of origin for modern knowledge? We believe that various cultures worldwide practice science in ways that have similarities to but also distinct differences from Western science. We believe that there are multiple origins for scientific knowledge, and that there are multiple ways of viewing the natural world. Evidence for the multiplicity of scientific world views comes from the examination of indigenous cultures, those cultures which have not yet lost their traditional knowledge and ways of thinking about the world.

That Western science has become the prototype for what counts as science today is not an indication that this is the only true science. Rather, it is the result of the dominance of Western culture over other cultures, to the point that other ways of thinking and doing science have been largely discredited by the Western scientific community in general and by modern educators in Western cultures.

Modern Western science seems to have lost track of its roots. Prior to laboratory testing, scientific hypotheses generally have their roots in observations and insights about the natural world. A tendency of educators to present laboratory science as the only true science has had the result of discrediting the scientific knowledge and practice of non-Western cultures, a science that relies foremost on naturalistic observation and insight.

The teaching of science in the United States is dominated with examples of the contributions of European and American scientists. The multitude of contributions of knowledge and ways of thinking of the many other cultures of the world have been largely ignored. In addition, modern science teaching presents scientific knowledge as a body of knowledge separated from other subject areas. This viewpoint makes science an activity foreign to the way of thinking of many non-Western cultures in which science is incorporated into daily life.

Evidence from the Yupiaq culture in southwestern Alaska demonstrates that indigenous cultures have developed their own scientific bodies of knowledge and way of thinking about the world that differs in crucial ways from that of Western science.

YUPIAQ CULTURE

The majority of residents in rural Alaska are Alaskan Natives who live in villages with small populations (25-5000 people per village). With some twenty Native languages spoken in the state, many school students speak their Native language as a first language. Many families in rural Alaska maintain a lifestyle that is largely dependent on subsistence hunting and fishing. Wild foods (salmon, caribou, moose, and numerous wild berries and herbs) form a major portion of their food supply, and many rural residents rely on commercial fishing in the summer months as their main financial support. Many villages are isolated by hundreds of miles from access to road systems.

The Yupiaq culture is one of several Native Alaskan cultures known as Eskimo. Members of this indigenous culture reside in southwestern Alaska, in an area of land larger than many individual states in the contiguous 48 states. Despite their isolation from the rest of the nation, rural villages have been affected greatly by modern Western culture. Televisions and telephones have become common. While dog sleds still are used recreationally, snow machines have become the more common mode of transportation and hunting in winter, and power boats have become common in the summer.

Teachers and administrators in rural schools are mostly non-Native and short-term. Western culture dominates the school setting and the curriculum. In the past, Native students were forbidden to speak their native language in the schools and Native cultural traditions were discouraged by schools. The activism of Native Alaskan groups has gradually brought change. Today, many schools offer classes in the local Native language and culture. Nonetheless, there remains a serious gap between the culture of the child at home and the culture of the child in school.

YUPIAQ CONTRIBUTIONS TO SCIENCE AND TECHNOLOGY

Native Alaskan scientific knowledge has largely been ignored by Western scientists. However, in recent years knowledge from indigenous Alaskan cultures has contributed to some Western scientific studies, such as environmental impact studies conducted in the Alaskan tundra. In the past few years, several studies of the traditional knowledge and practices of Yupiaq people have been conducted in southwestern Alaska. The Ciulistet group, an organization of Yupiaq teachers has conducted studies of Yupiaq mathematics and science in an effort to bring that knowledge directly into classrooms in Bristol Bay (Lipka, 1994a & b). Kawagley conducted an ethnographic study of Yupiaq knowledge and ways of knowing and doing science in Akiak, a small village of 385 people near Bethel, Alaska (Kawagley, 1995).

The Yupiaq people have invented numerous technological devices for hunting and fishing. They know which wild plants can be eaten and which have medicinal value. They know when and where to gather grasses for baskets. They know how to prepare clothing, including shoes and raingear, from animal products. They know how to prepare and preserve fish, moose, and caribou for long-term storage. They know how to store fish underground so that the flesh remains firm and does not spoil. And they know how to prepare underground shelters for protection from the cold.

While it is true that much of Yupiaq knowledge has been manifested most clearly in their technology, that technology did not spring out of a void. Their inventions, which include the kayak, river fish traps, and a wide range of hunting and fishing gear, represent technology that could not have been developed without extensive scientific study of the flow of currents in rivers, the ebb and flow of tides in bays, and the feeding, sleeping, and migratory habits of fish, mammals, and birds.

Yupiaq people have extensive knowledge of navigation on open seas, rivers, and over snow-covered tundra. They have their own terminology for constellations and have an understanding of the seasonal positionings of the constellations. They have developed a large body of knowledge about climatic and seasonal changes - knowledge about temperature changes, the behavior of ice and snow, the meanings of different cloud formations,

the significance of changes in wind direction and speed, and knowledge of air pressure. This knowledge has been crucial to survival and was essential for the development of the technological devices used in the past (and many still used today) for hunting and fishing.

Yupiaq scientific knowledge is based on deep observation of the natural surroundings. Traditionally, knowledge was passed down from the elders to the youth through story-telling. Fishing, hunting, food gathering and preparation practices were learned by children observing their elders.

Yupiaq mathematics differs significantly from modern mathematics. In times past, it was not important to measure things precisely. For example, it was not necessary to count the number of fish caught but to look at the space filled by the fish and compare it to years past. Land and waters were collectively owned, so there was no need for complex mathematical calculations of property boundaries.

YUPIAQ WORLD VIEW

In addition to a body of knowledge, Yupiaq ways of thinking about the world reflect a world view that is distinct from the Western way of thinking. In Yupiaq culture, science is not separated from daily life. Yupiaq science is interspersed with art, story-telling, hunting, and craftsmanship.

Kawagley (1995) found that Yupiaq villagers see themselves as the producers of knowledge. In their daily lives, men and women are the observers of their environment. There are no special gatekeepers of knowledge. The elders of the community are the repositories of traditional knowledge and they see it as their responsibility to educate the younger members. But Western culture has interfered with this traditional teaching and learning mode. Suppression of the Native language and culture has resulted in a generation of youth many of whom cannot communicate with the elders in their communities. The school teacher has replaced the elders as the transmitters of knowledge.

The Yupiaq have difficulty with many Western concepts and the words used to describe or define them. Western words come from a world view that is objectivistic and technomechanistic as opposed to the Yupiaq world view which is ecological and spiritual. Thus the concepts and word-thoughts (and metaphors) of the Yupiaq people are often ineffable because they are based on feelings of connectedness and relationships. Therein lies the Yupiaq problem with words like "science" and "mathematics" and the various scientific and mathematical disciplines and their concomitant terms and concepts. These all are strange and foreign to the Yupiaq. This points out the importance of revitalizing the Yupiaq language and traditions so that the nuances contained and the feelings conveyed in the Yupiaq words can continue with future generations.

Kawagley (1995) asked a group of Yupiaq elders to define mathematics and science. The elders' discussion of mathematics focused on the Yupiaq word *Cuqtaariyaraq*, "the process of measuring." Other definitions included "someone who is astute and perceptive"; "an expert evaluator"; "someone who evaluates something, mentally assessing the feasibility and coming pretty close to the estimate"; "becoming good at calculating"; "becoming good at visualizing." Finally, they agreed that the best Yupiaq definition of mathematics would be "the process of measuring and estimating in time and space."

Though no Yupiaq word exists for "science," the elders defined science as "trying to know," "trying to understand," "trying to grasp the origin," "trying to find the source," "way to try and understand through process of elimination," "the process of understanding," "a process that is the science of life," and "a process of seeing and predicting the future." In the course of the discussion the elders commented that "this is what our ancestors have said, they've said not to pollute the land. They've said that if we're not careful with our refuse, some animals, though they were plentiful once, will no longer be around. They were actually foreseeing their future when they told us that." "That's the science of life. We have to take care of our tundra in order to have plenty and have abundant wildlife."

Because scientific knowledge is incorporated into daily life, it is not sub-divided into different fields of science. In order to design a fish trap, one must know not only how the river behaves but also how the salmon behaves. Western culture segregates science from other realms of knowledge and even subdivides science into various categories. Often a scientist trained in one field lacks a well-rounded understanding of other scientific and non-scientific fields. As a biologist, Delena Norris-Tull has talked to physicists who knew little about evolutionary

theory and biologists who had a poor understanding of the major theories in physics. Scientific knowledge has become specialized to the point that the whole organism or the whole system is often not taken into account.

Yupiaq people do not separate science from spirituality. While they value observation highly they do not consider direct observation as the only way of attaining knowledge about the universe. Spiritual understanding is another way of obtaining knowledge - observing one's inner spirit, as well as one's outer environment, contributes to the whole range of Yupiaq knowledge.

Yupiaq people view the world as being comprised of five elements: earth, air, fire, water, and spirit. Aristotle spoke of the four elements, earth, air, fire, and water. But spirit has been missing from Western science. The incorporation of spirit in the Yupiaq world view resulted in an awareness of the interdependence of humanity with the environment, a reverence for and a sense of responsibility for protecting the environment. In the past, before the introduction of Western materials and ways of doing things, Yupiaq people practiced what may be thought of as soft technology: the making of tools, preparation of shelters, clothing, and food, was done with as little harm to the natural and supernatural worlds as possible. The shamans were the intermediaries between the spiritual and natural worlds. They informed the people of what was appropriate or not in their dealing with the earth. The use of natural materials made all objects ultimately recyclable. The people took extensive precautions to protect the lives of the animals and plants they depended upon for their existence.

Kawagley found that Native Alaskans are involved in the human effort to develop a world view consonant with themselves, nature, and the spiritual world. Such reverence for nature has been largely missing from Western cultural interactions with the environment. Einstein stated, "the ancients knew something that we seem to have forgotten. All means prove but a blunt instrument, if they have not behind them a living spirit" (Einstein, 1956, p. 24).

In Western culture today, science, philosophy, and metaphysics are treated as separate areas of study. And yet historically this division was not so apparent. Western scientific/philosophical thinking has often turned to questions about the nature of existence and of God. Even in modern physics, such great thinkers as Einstein and Hawking have not found it necessary to separate questions about God from questions about the behavior of the universe. And yet, many Western scientists and science educators today treat science and spirit as separate and unrelated entities. "Science without religion is lame, religion without science is blind" (Einstein, 1956, p. 26).

Native American cultures have no need to distinguish metaphysical from scientific questions - perhaps because of the belief that all knowledge comes from one source. In these cultures, logic, as it is based solely on sense-data, is not the only or even the most important source of knowledge. Inner knowledge that is separate from outer sensory knowledge has value and is part of the reality of their lives. Western scientific culture, in its empiricism, seems to deny the value of inner knowledge. Yet, without that inner knowledge, how would Einstein have developed his theories?

In Western science, the closest to Yupiaq science can be seen in the study of ecology, which incorporates biological, chemical, and physical systems (earth, air, fire, and water). But until very recently, even ecology has ignored the fifth element, spirit. This lack of attention to the fifth element has resulted in a science that ignores the interaction and needs of societies and cultures within ecosystems. Only recently has ecological study begun to incorporate human/social needs/concerns about changes in ecosystems.

CONCLUSION

Much scientific knowledge that we have today, for example, knowledge of the medicinal effects of tropical plants, came from the knowledge of indigenous cultures. Other larger cultures, such as the Chinese cultures have contributed much to modern knowledge. Modern scientific knowledge is a blend of the observations and insights of many different cultures. And yet, Western cultural perspectives dominate current ideas about what science is. And modern science is presented in classrooms as thought it had strictly a European origin.

We believe that evidence from indigenous cultures demonstrates that science is not just a one-time invention of European thought. Scientific bodies of knowledge and ways of thinking have emerged separately in a multitude of cultures worldwide. The science conducted in Western laboratories is largely a way of doing science that is Western in origin and is, in some crucial ways, distinct from the way that science is and has been done in

non-Western cultures. Western science tends to be impersonal, formal, and elitist. Indigenous science is informal and non-elitist. Western science promotes a mechanistic view of the universe. Indigenous science incorporates spirit.

There is a large body of science that exists in Yupiaq culture - but it is a science that is rapidly disappearing as the language is disappearing. Recent publicity has alerted us to concerns about the loss of knowledge of plant medicines in the Amazon rain forests as the Amazon tribes disappear. But we know very little about what we are losing as the cultures and languages of indigenous Alaskans disappear.

Western philosophy runs the risk of making the grievous error of thinking that there is one way to view the universe and that we have indeed discovered what that one way is. This paper challenges Western scientists and Western educators to look seriously at the ways of doing science and the world views of other cultures. The hegemony of Western science threatens to further disenfranchise indigenous cultures and perpetuates a colonialist attitude that cannot be defended in modern times.

IMPLICATIONS FOR CURRICULUM DEVELOPMENT AND PEDAGOGY

Incorporating Yupiaq knowledge, world view, and culture into science classroom content and practice requires some fundamental changes in the way students, teachers, and schools function. As these changes are analyzed, however, it becomes clear that these changes closely correspond to many of the changes in curriculum and pedagogy recommended in science reform documents such as *National Science Education Standards* (National Research Council, 1994) and *Science for All Americans* (Rutherford & Ahlgren, 1990).

Science curriculum, as it has historically appeared in rural Alaska, has been based on textbooks which, for example, assumed that grasshoppers, frogs, supermarkets and sidewalks were a part of every child's daily life. Science class presented students with a bewildering, largely irrelevant body of information in a different science subject each year. A Yupiaq world view, like the recent science reform documents, invokes a more holistic view of science, minimizing the artificial distinctions among discrete subjects in science, while emphasizing the interconnectedness and interdependence of all dimensions of nature and human activity. The Yupiaq heritage can bring to the classroom a multidisciplinary, multidirectional, and multisensory learning style, with the total environment, natural and artificial, as the learning laboratory.

What emerges from incorporating Native Alaskan world view, knowledge, and culture into Alaskan schools is a curriculum which integrates the natural sciences with social sciences, language arts, humanities, and mathematics in a way which the learner can recognize as having legitimate meaning in daily life. The spiritual element of Yupiaq understanding can manifest itself throughout the curriculum, not as religious instruction, but as such things as reverence for the natural world, acknowledgment of humanity's dependence on and responsibility to our ecosystem, and appreciation of the mysteries of the universe. Learning to respect the spirit of the river that flows by the village is infinitely more important than learning to draw a picture of an atom that appears in the textbook. It may also be a more precise metaphor.

Because Western methods of teaching science often run counter to the students' own cultural experiences, Yupiaq students have been disenfranchised not only by *what* was taught but also by *how* it was taught. Science has been taught through lecture, graded competitively, and involved remembering an enormous amount of unrelated abstract information with no clear use in real life.

Designing instructional materials and practices which acknowledge and respect Yupiaq society represents much more than just movement away from this outdated view of science and science teaching, however. It also represents significant progress *toward* the goals, outcomes, and recommendations of the recent science education reform documents, as well as being congruent with emerging understanding of the teaching and learning process. A classroom reflecting Yupiaq culture looks and feels much like the village outside the classroom door. Groups of individuals of various ages, from young children to the elders of the community, are engaged in hands-on activities, working together to complete meaningful tasks or to solve concrete, multifaceted problems relevant to their daily lives. The natural environmental setting is a common tool for learning. Both Yupiaq and English are spoken, as each has its own contribution to the learning, and, as Kawagley states, "we should make use of the Yupiaq language because it is a tool of the spirit and therefore the voice of the culture." Everyone has an opportunity to express opinions if they wish, and decisions are arrived at by consensus. Assessments are authentic and evaluations are

prescriptive; strengths are capitalized on, and weaknesses are worked on. Everyone is ultimately accountable for their own behavior, but--when necessary--quiet guidance may be provided by the group or by a respected individual. Where feasible, the elders are actively involved in telling the stories and demonstrating the crafts and practices of the Yupiaq heritage. Teachers and community members work together to assist students in strengthening their identification with their own culture while simultaneously embracing Western science as a second force that can help them maintain self-reliance and self-sufficiency.

Pedagogy that thus draws from indigenous knowledge, world view, and culture provides students with not only a locally relevant science education, but also in many ways provides them with the kind of learning environment and experiences recommended for students everywhere.

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